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SYSTEMATIZED AND SCIENTIFIC MANAGEMENT¹

The purpose of this paper is twofold; first to describe and explain if possible scientific management, not in technical terms, but by comparison with other types of management with which all are familiar, so as to show wherein it differs in the makeup of its elements; and secondly, to establish the setting, or, to use a phrase familiar in debating, to state the question.

Every manufacturing or mercantile business is made up of different processes which are more or less interdependent. In order to secure the best results, it must be so organized that the separate processes, and the unit members within these, will be brought into systematic connection and operation as efficient parts of the whole. To bring about and maintain this result is the function of management: to do it to the highest known degree is possible only by what we choose to call the science of management.

All types of management seem to fall into three general classes, which, for want of a better terminology, we shall call (1) unsystematized, (2) systematized, and (3) scientific. Of course no classification of this kind is exact. Some departments of a business may be conducted according to the standard of one, while other departments may be in another class, but on the whole, this seems a natural division.

Let us look briefly at the five important features of every manufacturing plant, excluding designing, advertising and selling. These are: (1) accounting and costs, (2) purchasing, (3) storage of materials, (4) execution of the work, and (5) efficiency of the worker.

We shall pass hurriedly over these five features of the unsystematized type of industry, because this type is so well known, and is

¹ Much of the substance of this article—a paper read at the Western Economic Society's conference on Scientific Management, March 14, 1913—has been used previously in the author's address on "Types of Management" before the Tuck School of Dartmouth College. Nevertheless, the article is printed here, with the consent of the Director of the Tuck School, because of its relation to other articles in this and preceding issues of *The Journal of Political Economy*.—THE EDITORS.

seen everywhere. It earns its title "unsystematized," not because its profits may be unsatisfactory, since profits are an indication of difference between costs and selling values only, and may for a variety of reasons not be dependent on an efficient form of organization, but because, as an organization for efficient work, it leaves much to be done.

The unsystematized business still depends for its accurate knowledge on the balance sheet, secured after the annual inventory is taken, which may be weeks or months after the year's business is closed. Very little attention is paid to accurate cost systems, monthly earning sheets, etc. Purchasing is done without the aid of accurate specifications, and complete knowledge of the quantities on hand and available. Stores and merchandise are generally in disorder; and accurate information as to location and quantities is wanting, as are suitable storage facilities. The execution of the work depends on the verbal or incomplete information which is passed down the line from sales department to workman, each man from manager, superintendent, foreman, and boss, adding from his knowledge and experience, with the intention of ultimately informing the journeyman worker what is wanted, but really relying on him to produce it. Under such management, the efficiency of the man and machine cannot help being low, especially in comparison with the other types. Unsystematized shops of this description are run on the single foremanship plan.

SYSTEMATIZED MANAGEMENT

Wherein does systematized management materially differ from scientific management? It is methodical, desires all departments to be run in an orderly fashion, and gets them to going that way. It asks: "What more can be done? Isn't this the highest form of organization known, and can there be anything much better? Isn't scientific management only another name for what I have, and are not its alleged superior results apparent only in contrast with the unsystematized plant?" To show that the form of scientific management is fundamentally different, and to show that the results of well-known elements, used in a different combination, is different, is the task set us.

We must admit at the start that a well-systematized plant has great advantages over the unsystematized, that much of the organization work has been well done, and that the efficiency of parts is good. Let us take, however, a brief look at the systematized form of business and endeavor to do it full justice.

1. *Accounting*.—Accounting in a business includes not only the ordinary bookkeeping, but the entire clerical system which has to do with orders, records and costs. Accounting is the only means by which the management is informed from time to time of the condition of the business, the progress it is making, its weak and strong points, its selling values and costs, and the efficiency of all its departments. How thorough, lucid and complete the information is, as shown by the books, indicates to some extent the efficiency of the management and its grasp on the affairs of the company. In the unsystematized plant the accounting generally consists of a statement prepared after the annual or semiannual stock-taking, which shows (1) Profit and Loss; (2) Assets and Liabilities. It may possibly show profit and loss by departments or by products, but this last depends on a correct method of ascertaining costs which the unsystematized plant seldom has. Such statements are merely a record of an historical fact in most cases. If the statement is bad it is too late to remedy the troubles of the previous year because it shows merely the result of that year. Frequently, owing to imperfect methods of stock-taking, appraising and compiling, the yearly statement may be delayed; the history it tells then is ancient.

Under systematized management that has been changed. The books now show the condition of the business quarterly or monthly and in considerable detail. This detail will include the comparative feature; that is, for example, last year's cost to date with this year's cost for the same period, for a given department or product; it will show costs of materials and labor, and the proportion of overhead charges that make up the cost of a single job or a given product. Such results may even be charted and shown in graphic form to the management each month. Other records will come up weekly or even daily. As accounting is the means by which is ascertained the exact condition of the business at a given time, the systematized

management recognizes the importance of this information. Much of this accounting, however, is done with the ultimate end of securing correct costs, and these cost data are relied upon almost wholly, (1) to establish the selling price, and (2) to point out excessive costs and indicate perhaps where they may be reduced. Many persons believe that when their accounting is well done they have a systematized and efficient plant, but this really covers one phase only of the management.

Frequently, too, the clerical work in the different departments is not a part of the general accounting, and is not controlled by the ledger accounts. In other words, the same general system of accounting does not permeate the whole plant and help to support itself.

2. *Purchasing*.—The purchasing of materials, stock and miscellaneous supplies under unsystematized management may be done by one man or by a purchasing department; but more likely this duty is not very well defined and the purchasing is done by a number of persons, especially those needing the material. Little study is put on the standardization of materials, and different kinds of stock for the same use are often bought. This tends to remnants on some kinds, overstock and understock on others. The buying is seldom done on exact specifications, and not always even by written order, nor is there a predetermined maximum and minimum established for each article that should be carried in stock. The head of the business or the buyer may be an exceedingly shrewd trader and may buy very closely at times; but he will not always buy the materials best suited to the work, often overbuys or underbuys for lack of definite information, and is frequently tempted by bargain lots that seem cheap but may cost more to use in the shop. Then too, much more money is tied up in materials and storage space than is required.

In systematized management materials and supplies are purchased through one man or department, a maximum and a minimum are generally established, and a decided effort made to purchase the materials best suited to the workrooms. Some analytic methods are used in determining the proper materials, and standardizing is done on the more important kinds. This purchasing depart-

ment aims to have a stock of everything required, but buys largely what it is asked to buy. It does not always make purchases on complete specifications, and a lack of thorough standardization increases the detail of that department. So far as the clerical system is developed, however, it is generally good.

A well-known railroad president some time ago stated, at the Interstate Commerce hearings, that the railroads had reached their ultimate goal of efficiency. It is interesting in the light of this statement to note an example of efficiency in purchasing by one system of railroads, which has been acknowledged by railroad officials as leading in this particular department. This is the purchasing done by Mr. Thorne, who buys over \$40,000,000 worth of materials annually for the Union Pacific and Southern Pacific railroad systems. When Mr. Harriman took over a railroad he would go to any expense in order to standardize every particle of material used. Mr. Thorne is the man who carried this out. In a letter some time since he told me that in the standardization of printed forms alone he had saved over 30 per cent in the purchase of that particular commodity. From what I have seen of the methods of this office, I believe that a large percentage has been saved over what was customary earlier in the history of that railroad, and over what is customary in a good many competing roads today. It would require no such percentage of saving in the balance of the forty million dollars of supplies annually purchased, as was saved on the printed forms, to make a very material lessening of the budget of those roads.

3. *Storage of materials.*—Many manufacturers are willing to devote unlimited space to workrooms, not realizing that the room for the proper storage of materials is just as important and just as profitable as that used for manufacture. In the unsystematized plant there may be a general storeroom, but seldom are all the stores to be found in it, and generally they are piled around almost anywhere and in any way that happened to be convenient when they were received. The order in which such stores are kept usually depends upon the initiative of the men directly in charge, and seldom can one person assume or carry out this responsibility.

The storage of materials and purchasing are very closely related

to each other. Loss of time hunting for material is the same whether the material is lost in the storeroom or has not been purchased, and a lack of system in one department will undo attempts at system in the others.

A marked contrast to these storage methods will be seen at once in the systematized plant. Here is an adequate room in charge of a storekeeper who issues stores only on requisitions, and who is expected to keep his place neat and orderly and to deliver his stores on call. A perpetual list is kept in the office and balanced with the stores, and the balance is proved by an actual count of the stores once a year or oftener. Stores are partially classified and standardized to some extent. It is only the most-used stores that are assigned to orders before they are actually called for. The physical handling of the stores, moving them in and out of the storeroom, is done by the assistants of the storekeeper and the efficiency of this work and the orderliness of the department depend wholly upon the kind of man in charge. The central office can exercise very little real control in this department.

Not all systematized plants control work from a central planning station by writing the operations for each process before the work is started; therefore materials are not exactly predetermined and work is still likely to be started before it is discovered that some material is lacking. Neither are the quantities always kept up automatically through the purchasing department by a predetermined maximum and minimum of each kind. It is general practice also to have storage space for different departments, some of which are not under control of the office; for instance the miscellaneous supplies used for the power department for repairs, piping and plumbing, electrical maintenance, etc., may be scattered about with little idea of order, while the actual materials for use in manufacture may be in good order.

4. *Execution of work.*—Orders in the unsystematized shop are recorded in a simple manner, sometimes even received and transmitted orally by the salesman. These are described in part orally to the superintendent, who may further enlighten the foreman on any of the details of such orders. It is assumed that the superintendent knows his business, that the foremen know theirs, and a

workman is expected to sense what is wanted and to ask questions when he is not sure. In this way an attempt is made to fill in the exact and accurate information which the selling end either has not secured or has not transmitted in writing.

The "single foremanship" plan prevails where one foreman handles as many men as he can. The number of men and the amount of work he can look out for is limited by the amount of detail he can carry in his head and by his physical and nervous endurance. He gives work to each workman when the latter has finished his last job, and depends largely on the worker's knowledge of what to do and how to do it. As questions arise in the progress of the work, or where the written order is incomplete, the workman goes to the foreman who in turn goes to the office for instructions. Meanwhile progress on the work stops.

The workman goes for and selects his tools and appliances, and does his work in the way in which he is accustomed to do that particular kind of work. A difference in method of doing the same kind of work by different workmen and in different shops is often quite marked. A detailed schedule of the average workman's day in the unsystematized shop, where such day's work is varied, will show a surprisingly small proportion of effective time.

Piece-work is often used, but is bound to lead to inequality. The rates, determined by no exact method, are often subject to change, and the output of such piece-work is frequently limited by the unions.

In the systematized plant, this crude rule of thumb method has been changed. A complete set of order-cards for recording and transmitting orders is in use. The worker receives a written order for the work he is to do. But this seldom takes the form of an instruction card giving him complete information for every move and every tool. It is likely to say *what* the work is, assuming that he will do it in a satisfactory manner. Workers almost always record their time for each job on a card, which registers the labor cost accurately. They do not always register the time lost in securing tools, materials and further instructions. The planning of a job, except in plants where the work is very largely repetition, is likely to be done as the work proceeds. Piece-work is used wherever

possible and is considered the most economical way of performing a given operation. It is the aim of most systematized plants to secure as much piece-work as possible. This may be unfair for different kinds of work to both employees and employer.

Systematized management keeps things running smoothly, avoids most of the mistakes due to the lax methods of unsystematized management and turns out a good product. But a lack of centralized planning and centralized control of the workers causes loss of efficiency. This is especially true in rush times, or when certain parts of a factory are congested. It is impossible then, with the means at hand, so to plan the work as to get it out to the best advantage; for with the foreman of one room or department planning his work, and another his, the two can seldom be made to interlock perfectly.

5. *Efficiency of the worker.*—Emphasis under systematized management is laid on knowledge of what the costs are, freedom from mistakes and bad work, and the greatest output of man and machine that can be secured. The standard for this output is generally established by the opinions or experience of the bosses, who have neither the time nor the training to ascertain it by exact methods. Great emphasis is put upon the installation of new and modern machinery, but not very much analytical work is done by the management to ascertain whether the worker is working in the very best possible way, or whether he is adapted to the particular job he is given. The person who has charge of the employment considers that there are four classes of people: men, women, boys and girls. If the foreman wants a girl, that is sufficient information for the one in charge of the employment, and a girl is hired and assigned. Little or no thought is given to the question whether that particular girl is the right one for the task.

For instance, in bookbinding there are different kinds of work. Laying gold leaf calls for a girl with small fingers and a delicate touch. Strength is not required. Another operation calls for a large, strong girl, who can easily handle bundles of work weighing seven or eight pounds. In proofreading the time reaction of seeing a word and grasping its meaning is a very important feature. Other girls doing inspection must have the ability to concentrate their

minds on one particular operation. The different kinds of work demand girls selected with special reference to their aptitude for their particular work. In every factory will be found workers in one department who cannot successfully do their work, but who could successfully do work of another kind. The scientific selection of the worker is almost unknown in the merely systematized plant, and this fact alone makes impossible the highest efficiency. Unfitness to work will cause a greater loss of earning power than most persons realize.

When I think over the psychology of industrial workers, I am reminded of my own experience in college. In the psychological laboratory tests were made on all my class. I had the quickest time reaction from seeing a flash to muscular action in pressing a button; I had the slowest time reaction in the class to seeing a word, comprehending its meaning, and then pressing a button which registered the time it had taken me to see and comprehend its meaning. This experiment showed why I was the slowest reader in my class and why on a given task in reading, in literature or any other subject, I took longer than anyone else. While I was not a sprinter, my record for the fifteen-yard dash has never been beaten,—not because I was a fast runner, but simply because the time reaction to muscular effort enabled me to get off more quickly after the pistol shot than anyone else. Now suppose that my whole course of training had been guided by my parents, as is the case with many, and that they had decided that after I left grammar school I should begin apprenticeship in a shop in a line of work in which my physical makeup would prevent my competing with others, or that I should study for music, book-keeping, accounting, typewriting, telegraphy, or any one of a hundred trades requiring the ability to read rapidly. Consider the certain outcome of such a selection.

The step from unsystematized to systematized management is a difficult one because it generally means a more radical change in the personnel of the supervisory force than does the further step. The unsystematic management is likely to associate with him men of a similar type. To do one's work in a systematic way is not wholly a matter of training, and the foremen and superintendents

in a thoroughly unsystematized plant cannot always develop the habit of working by means of system. The unsystematized plant still exists, either because its competitors are in the same condition or because there is a large difference between costs and selling price, or because the business is dominated by one or more strong characters whose ability in other phases of their work more than makes up for their lack in organizing ability. Sooner or later, however, this class of industries will be forced to change or be eliminated. This has already taken place in a number of industries, as for example, in the manufacture of shoes.

Twenty-five or thirty years ago there were more shoe shops than there are today. The competition in manufacturing shoes and the intricacy of the detail have made it impossible for the unsystematized plant to grow beyond the limit of the single foremanship plan, with the result that only the systematized plants could increase. The others were absorbed or ceased to be, and today there is probably not an unsystematized plant engaged in the manufacture of shoes. Indeed, some few shoe manufacturing concerns are developing scientific management very rapidly in all their departments. And what has happened to the shoe industry is now happening to other industries which are in the transitional period through which the shoe manufacturing industry passed twenty or twenty-five years ago.

The difficulty in the step from the systematized management to the scientific is not so much that of the personnel, as in the training of the personnel to work the new way, and especially in effecting the change in the mental attitude, which generally is a slow one. The qualities that mean success in the systematized management are just the ones needed in the other.

SCIENTIFIC MANAGEMENT

Those who have read the newspaper reports of the spectacular results accomplished in some instances by scientific management, without knowing how they occurred, have felt that there was some mystery about this new form of management which they did not understand. The feeling has prevailed that some method was used to drive the workman to superhuman effort, and that the management contributed little or nothing to this except the bait.

If you go through a certain shop, you see certain familiar machines, arranged in proper sequence and proportion, together with the store-rooms, drafting-rooms, and so on; you see sheet steel, rivets, etc., in different processes, until at the end the product is a boiler. In another shop you see similar machines, of different size, perhaps, arranged in different sequences and proportion, with drafting-rooms, store-rooms, and some different elements also, and the product is a ship.

Now there are very few, if any, new elements comprising scientific management; but a new combination, a different proportion, another sequence, the whole making a different form of organization.

Having described the phases of the other type, let us look at this. Let it be understood that scientific management cannot be complete until every functional part is working perfectly, for here is a whole plan, every part interlocking with the other, and interdependent.

1. *Accounting*.—Accounting under scientific management shows the manufacturing and expense accounts for the year, preferably by thirteen periods of four weeks each, rather than by twelve monthly periods; and at the expiration of each of these periods it shows the profit and loss, and assets and liabilities. These in the unsystematized plant are shown yearly, and not always in the systematized plant are they shown even monthly. Further, the group and unit costs of the various products, the cost and output of each department and all expenses which might be applied directly to the product, are shown in full, and the “comparative” features are much more useful in four-week periods because these give a more equal basis for comparison. A monthly statement as shown by the books in the systematized accounting does not give an accurate comparison because, for instance, some months will have five pay-rolls where others have four, and the number of working days varies considerably, because there may be five Sundays or five Saturday half-days.

In substance, the general accounts of the company are shown in more complete form every four-week period than is shown by the yearly accounting in the systematized class. The ledger accounts have absolute control over the stores department, over

the quantity and value of stores, work and materials in process and manufactured goods; and as every department and function of the manufacturing co-ordinates with every other, the accounting becomes a part of the very bone and fiber of the manufacturing.

One radical difference in point of view is that the ascertaining of costs does not have a special system installed for just that purpose, and the ascertaining of costs is not the end sought. Under scientific management costs come as a by-product of the means used for increasing efficiency. For instance, a ticket made up in the central planning department, when combined with the instruction card, serves to plan the work in advance; then it is used to control the order of work by being placed on a bulletin board; then it gives the workman his particular piece of work to do with the instructions how to do it. On this ticket is stamped the time at which the work is begun and the time when it ends. This same ticket then serves to check off the progress of the work on the route-sheet. Then it goes to the accounting department from which the man's pay is made up. It is then redistributed and furnishes the labor cost of the particular operation on the cost-sheet of the job. From cost-sheets similar to this are summarized not only the cost on all jobs, but department expenses and charges which appear in each four-week period statement. In other words, the mechanism used under systematized management for ascertaining costs performs little other work; under scientific management it has performed its part in producing work, and from it, as a by-product, so to speak, come the costs. The ascertaining of costs by this method is effected with but little more expense than is necessary for handling the regular work of operation.

Too much emphasis cannot be placed on the value of the comparative feature in accounting. Comparisons are a great spur to increased efficiency, and this fact is recognized as well in the systematized management. For example: a certain group of department stores, each doing a business in a different city and non-competitive, have found such good results from uniform accounting methods and the information that comes from comparison, that they jointly employ an accountant who collects the monthly reports in detail from these stores so as to make a compari-

son by items, and then prints these data for the use of the management of each store. Thus one manager finds that Department A in his store did \$50,000 worth of business the preceding month, and had \$35,000 worth of stock on hand; and he is shown in detail what the labor and other expense items of that department were. He sees that another store did \$55,000 worth of business in Department A and had a stock of but \$20,000. He immediately summons his buyer and informs him of the result of this comparison, and asks why he cannot do as well as the buyer in the other store and release \$15,000 of capital now tied up in stock. The knowledge of what can be done and is done by the other store is often sufficient stimulus in itself to cause to be accomplished what otherwise would not be considered possible.

The expense and frequently the shutdowns for the purpose of the annual stock-taking are eliminated under scientific management, because the accounting absolutely controls the movement of materials in and out of the stores department. Its records therefore show at all times the amount in stores whence the value of the stores can be ascertained when desired. The work of proving the items of stores is done continuously, and the days, which often become weeks and months, that elapse before even large and well-organized concerns get the results of their stock-taking, become a thing of the past. One large concern with which I am acquainted finished its year of stock-taking January 1, and it was early in August of that year before it got the results and knew how much stock it had on hand January 1. The same will apply to the amount of materials and labor in process, which the systematized management finds it even a harder problem to handle, and also to the value of manufactured goods.

2. *Purchasing*.—Scientific management is not satisfied merely to have plenty of materials on hand when wanted, to standardize roughly the principal items of stock used and to buy at the market rate, but demands that all materials be carefully studied with reference to—

First, The greatest adaptability to the work.

Second, Quality and uniformity.

Third, Price.

Fourth, Determination of the proper maximum and minimum amount that shall be carried, so that the stores department may automatically control materials and supplies which should always be on hand.

When this has been accomplished, care is taken to make all purchases on detailed specifications. The importance of using the materials which are best suited to the work, of maintaining uniformity of quality and of reducing the number of necessary materials to a minimum by standardization, is not sufficiently appreciated by the buyer in even the systematized plant. For example, a manufacturer of razors using a thin blade could not secure a steel which would always act in the same way and produce a uniform result with uniform treatment. He employed a steel expert of reputation to assist him. This expert purchased the best razors that different barbers had, analyzed them chemically and microscopically and, as every man who uses a razor might guess, found very great variation even in the same makes. In fact, he satisfied himself that no razor manufacturer, however well-systematized his plant was, had ever scientifically determined the best steel or purchased it on a formula that would standardize this material. As a result, all these years the buying of a razor had been a lottery. After many tests this expert secured from various steel manufacturers samples of steel on their formulae and his own, and he finally developed a formula that would give the best razor steel known and maintain it uniform. In consequence of this method of buying this manufacturer stood alone among the razor producers of the country in ability to produce razor blades of standard quality. If all his methods are as scientific as this, it is doubtful whether his competitors will ever overtake the lead he has secured. This is not an extreme example by any means.

Take another illustration of the standardizing of materials. In studying the supplies of a business it was found that twelve kinds of wrapping paper were in regular use and that an investment of \$2,500 was needed to carry a sufficient amount. By standardization the twelve kinds of paper have now been reduced to four, with a saving of \$1,000 in the stock, and of 60 per cent in the storage space occupied. Moreover, the available worth of this

paper for the demands that may be made on it is 20 per cent more than it was formerly. This illustrates the saving made on but one class of material used in a factory where standardization is being worked out.

Such methods of purchasing compel the purchasing department to be intimately associated with the working of the materials through manufacture, and lead to the following results:

First. Uniform material best adapted to the work, saving labor and delay in workrooms.

Second. A minimum of kinds and sizes necessarily carried.

Third. Storage space saved.

Fourth. Lower costs through buying in larger lots.

3. *Storage of materials.*—In its physical aspects a storeroom under scientific management does not differ greatly from one that is systematized. A proper means of holding or piling the stores, laid out in an orderly fashion, is provided. To avoid confusion in a varied terminology, mnemonic symbols are used to designate the different kinds of stores. The maximum and minimum quantities mentioned above are determined for each kind, and kept on the ledger sheets in the central planning room. The book-keeping for the stores is not carried on in the storeroom. The storeroom force acts only on receipt of written order. The location of the materials is also indicated on the ledger sheets, or, as they are sometimes known, the balance of stores sheets.

The storeroom in the systematized plant does not ordinarily provide for all the materials and supplies used in the entire plant. The engine-room, plumbing and construction supplies may be carried in places provided for them, but not under proper control. Stationery and office forms and supplies may be carried somewhere else, under a different system, or with no system. Even in well-systematized plants such items as are not considered a part of the general stores system cause more or less trouble by being used up unexpectedly.

Under scientific management it is not sufficient, when materials are required, to send a requisition to the stores department. Instead, all orders or work which require material have the items looked up and assigned to the specific orders by stores clerks, and

this material when assigned to a given order is not available for another order which may follow. This is done before the materials are required for use, and this method serves as advance warning to the stores clerks if an unexpected demand for a particular material is likely to occur. Quick action is then possible in purchasing more.

The work of moving materials into the stores department and moving them from the stores department to the particular place where they are to be used, becomes a function of the planning and routing of the work, and the workman who is to use them should not be delayed or have to give a thought to the materials which he needs for his next job. They are moved in the right condition for his use to the point where he can use them to the best advantage. The time which the workman spends looking for or waiting for his materials can be better spent in effective work. The proper working of the stores department in many industries, and especially in mercantile establishments, is very important.

4. *Execution of work.*—The theory of the proper execution of work is that it should be planned completely before a single move is made—that a route-sheet which will show the names and order of all the operations which are to be performed should be made out and that instruction cards should be clearly written for each operation. Requisitions on the stores department showing the kind and quality of the materials and where they should be moved, and lists of proper tools for doing the work in the best way, should be made up for each operation. Then, by time-study the very best method and apparatus for performing each operation is determined in advance, and becomes a part of the instruction cards.

By this means the order and assignment of all work, or routing as it is called, should be conducted by the central planning or routing department. This brings the control of all operations in the plant, the progress and order of the work, back to the central point. Information which even in the systematized plant is supposed to be furnished by the knowledge of the workman or the gang-boss or foreman, is brought back to the planning room and becomes a part of the instruction card.

In systematized plants generally no attempt is made to change

the method by which the workman performs his operations. Plenty of time and money may be spent on special machinery, but when that is installed very little time is spent in a close analytical study of the time elements and motions involved in operating, in order to make it possible for the workman to work in the easiest and best way and to furnish a fair basis of remuneration.

When the analytical study has been made, the probable time of operation determined, and a sufficient incentive has been added in the shape of a bonus for performing the work in the given time and in the way specified, then work can be much more accurately controlled from the central planning room because it is likely to be done in approximately the time determined and without lagging.

By *functional foremanship*, the management brings to bear on each phase of the work the abilities of a man particularly fitted by selection, training and experience to assist in performing that part of the work. His duty is to assist the worker and co-operate with him to enable him to increase his earning capacity by eliminating trouble or delays or wrong methods. Even in the well-managed systematized plant the manager will tell you that the weak point in his business is the inability to secure good foremen, or good superintendents. He demands:

First. That a foreman shall know all about the work which is done in his department.

Second. That he be a good disciplinarian.

Third. That he have the ability to crowd work through and get it out quickly.

Fourth. That he be cautious and accurate.

Fifth. That he be able to keep account of innumerable details.

To find all these qualities combined successfully in one man is exceedingly difficult, to train such men is also difficult, and to secure them by natural selection and "survival of the fittest" takes too long; but to train men for functional foremanship by selecting the man best fitted to do the particular function and then training him in that, is simply one kind of division of labor which has marked the progress of civilization.

The execution of work which is largely repetition, where the individual processes are simple, reaches a very high efficiency in

many systematized plants. The difficulties in securing efficiency increase as the work becomes more varied and with less proportion of it repeat-work, and in proportion as these difficulties increase ordinary systems fail to produce results in more intricate work. Results can be attained, however, by the central planning room from the analysis and time-study which is put into all operations of work and reduced to instruction cards.

5. *Efficiency of the worker.*—In many simple operations in manufacturing, piece-work has always been considered the most efficient method of securing output and low costs, and it is true that where the remuneration is a just one and when the employee is supplied with proper materials and works to the best advantage, this method of performing work approaches very closely to that of scientific management; but such conditions of piece-work are the ideal rather than the usual. As before stated, piece-work with prices based on the snap judgment of a foreman or by an imperfect test of a single worker, is not the correct method to secure the best efficiency or the fairest remuneration to the worker. Besides, there are many kinds of work which are not adapted to piece-work. Under scientific management the efficiency of the worker and machine depends on five other conditions, after assuming that the parts of the management which have to do with purchasing, storage of materials, etc., are well performed. These conditions are:

First. Analysis and synthesis of the elements of operation.

Second. Scientific selection of the worker.

Third. Training of the worker.

Fourth. Proper tools and equipment.

Fifth. Proper incentive. All these conditions it is the duty of the management to provide.

First. The first condition on which the efficiency of the worker depends is that *the management shall analyze carefully and thoroughly every operation into its ultimate elements; shall then recombine those elements in their proper sequence, eliminating those which are unnecessary or those which are bad, and reducing the form to a written instruction card for the worker to follow; the time elements having been determined and becoming a part of the instruction card.* It is interesting to see what develops when one really begins

to study a seemingly simple operation. The motion-study alone of brick-laying makes possible the elimination of sixteen unnecessary motions.

One factory doing light manufacturing has lately put some time into studying what have always been considered simple operations. In certain places a differently shaped receptacle was made for the articles on which work was being done, bringing the pieces within six inches of the left hand, whereas for years before the worker had had to reach for these and occasionally stop work to bring the articles farthest away within reach with a sort of hoe. Other operations in this plant have been simplified by changing the position of some workers so that the porter who supplies materials can do so without interrupting and causing a stop in the work several times a day. A study of extra steps and little delays by an intelligent observer is a necessary work before the greatest efficiency can be secured. When all these analyses have been reduced to writing, a study of the type of man best fitted to do this work is made.

Second. This leads to the second heading. The type of worker who physically and mentally is best fitted to do a given kind of work must be selected after a careful study of that class of operations, made with reference to the physiological and mental differences in human beings. The difference in output and quality of work has been found to vary as much as 40 per cent or 50 per cent in a group of men or women engaged on the same kind of work. As these persons were of apparently equal intelligence and education, the diverse results could be explained only by physiological and mental differences. As a result of time-study and motion-study of various groups of operations in one large manufacturing plant, it has been found that there are so many workers performing a kind of work to which they are not suited, but who might excel in another kind of work, that the management has laid plans to establish classes to instruct workers to do another kind of work better adapted to their capacities. In fact, when a study was made of two small groups of workers, it was found that over twenty per cent of each group could not successfully compete with their fellow workers in the same group, but were well fitted

to earn just as much in another group, and a change was made to the benefit of all concerned.

The laws governing the appeal of advertising have recently been explained by the application of psychology. The laws of fitness—mental, nervous and physical adaptation to occupation—are still a great field for research. Teachers in the vocational schools cannot perform their true functions until they come to a better knowledge of the demands of each occupation upon one's nervous, mental or physical being, and until they have some method of observation or test by which they can divert their pupils from entering these occupations in which they will clearly be a misfit. The late French psychologist, Binet, was able by tests to ascertain with apparent certainty, in a very few minutes, whether a child was mentally alert or not. Several applications of the Binet tests have already been made in this country.

Is it unreasonable to hope that some experimental psychologist may see the great aid work of this kind might be, if only carried on to help differentiate the mentally alert and to make tests of this kind practical? Scientific selection of the workmen is but a part; the scientific selection of *foremen*, of *superintendents and managers is just as important*. How frequently one sees a man struggling with the details of an office or with the wear and tear of executive work, on the verge of nervous prostration, when that man is wholly unfitted for that kind of work and his attempts successfully to perform it result in his undoing. If managers themselves knew how to judge a man's fitness for his work and were more observing, there would be far fewer breakdowns and physical wrecks than there are now.

Third. Having first carried out the study of the operation which has pointed the way to the proper selection of the worker, it becomes a duty to train the worker to do the work in the way which the result of the analysis has shown to be the best way. This will be accomplished by a functional foreman whose task is to train the workmen and help them to start right on each job. If they fail to do the task in the time fixed it is the duty of of the functional foreman to find out why they have failed, and to help them do the work as it should have been done. This is a

wide departure from the old school, which assumes that the journeyman has sufficient knowledge to do his own work in the most efficient manner. In the training of workmen it is interesting to see how they develop through an aroused interest and the co-operation of those over them.

The training of the adult worker is a condition that faces us now, but we should not be slow to realize that the boy is father to the man. The lack of trade schools to give thorough training in the manual arts and trades, must be met by the far-sighted manufacturer. This he should do by helping promote such excellent ideas in technical training as those originated by the University of Cincinnati, and other good school systems so that they may be within the reach of all. He should do it also by carefully worked out apprenticeship methods, and the many other helps such as class work that one can give the young worker. This can often be carried on in dull times with little additional expense.

Fourth. The fourth condition is that the worker be supplied with the best tools and just the ones needed for the particular operation, and supplied when needed; that he be given the best machine, maintained in first-class condition, so that machine, belt and tool failures will be reduced to the minimum. Any special tools or special fittings required for a job should be determined beforehand and should be within reach as wanted. To maintain machinery and provide such tools is the duty of the management. Scientific management provides the means with which to do this.

Fifth. Sufficient incentive should be given the worker to perform in the given time the operation or the task that has been set. The functional foreman trained to his specialty will do this more effectively than the old-fashioned all-around foreman. Many examples have been given of relative increase in efficiency of the worker as a result of scientific management. Of course such relative increases in output cannot be considered universal. Certain machines are not mechanically able to run at double or triple their former speeds, but scientific management tends to lessen the numberless little delays which the condition of the machine, the state of the material to be worked upon, or the instructions to the worker, may have been responsible for.

It must be to the financial interest of the worker to be industrious, and it has been shown to be for the interest of the management to do everything to make possible and profitable this increased industry of the worker, thereby gaining a more uniform output, and an output per man or machine which is maintained more steadily in dull or busy times.

There is another feature which is of interest; that is, if the worker engaged on the task and bonus does not receive his materials promptly and on time, if his machine is not in the condition it should be, or there are other avoidable delays, the worker has sufficient interest in the probable loss of his bonus to make a serious protest, and it is the duty of the gang-boss to right this trouble immediately. Therefore, the workman and the boss are together demanding of the management that as nearly as possible perfect working conditions be maintained.

CONCLUSION

The central planning and control of work which is such a vital part in scientific management is not developed to the same degree in the systematized. In such plants where complete planning is attempted, however, the instructions and orders particularize *what* is to be done rather than *how* it is to be done.

In the systematized plant the system in one department has been planned especially for that department, and is not a part of the system framework which pervades the whole, as in scientific management, and it is a constant fight to maintain such independent systems and especially to change and modify them with changed conditions or the increased growth of the business.

In closing let us see the effects of this type of management in general on the plant, the product, the worker and the management.

Plant.—Scientific management furnishes the machinery for maintaining the plant in better condition by centralizing the control, by the use of such devices as the standing order file in which are collected and reduced to writing and properly indexed the practices and rules of the company. From it, by listing and making a certain program of things to be done—the departments, machinery, and shafting, to be overhauled, drains, gutters, etc., to be inspected—this program can be handled month after month

by routine in a manner which the management has carefully predetermined. To attend to the maintenance of a plant in this way is working to prevent delay and expense rather than to cure it afterwards. For instance, eliminating delays due to belt failures, shaft-boxes which have been overlooked and run dry, and indefinite inspection of premises, pipe lines, traps, etc., tends to save expense by preventing trouble.

Product.—The product of such a scientifically managed plant should be and is more uniform, and there should be fewer mistakes and less inferior work. Organized inspection is a part of the plan. Once a standard is set for each operation, that standard can be maintained. It costs little more to maintain a high standard under these conditions than a low one under old conditions.

The worker.—The condition of a worker's mind has a very large effect on his physical being. There is a psychological effect on a worker in having the work divided into definite tasks, each one having its goal in sight and sustaining effort to that time. The piece-workers in a plant in which I am interested were once interviewed by a woman journalist who asked them how they liked the task and bonus. They said they didn't know why it was, but they liked it; they were earning more. But that was not all: the piece-work flowing to them in an unending stream had been discouraging; there was something they could not understand, but when it was broken up into definite lots they liked it much better. You can discourage any man by setting him to work with a pick and shovel and telling him to shovel away a hill. He knows he can never get it done, but if you say: "Here, you shovel so many tip-carts full in a day, or in a given time, and you shall have a certain percentage of increase of pay for that time," you have changed the point of view, and that man every time he finishes a tip-cart full has accomplished a definite task. His effort is sustained for that time, and he is going to be able to sustain that effort in the future. That is one reason why profit-sharing among the working classes is almost an absolute failure so far as increased efficiency is concerned; the time of sustained effort for a year or six months is too long. Neither can a worker do his best work who is nagged by a foreman, who has been given insufficient instructions and is fearful lest he is doing his work wrong, and who, having made a mistake,

is jumped on, oftentimes perhaps unjustly. He is not in a frame of mind to do his best work if he wishes to.

In one factory there was great difficulty in keeping the women workers in a certain department. Either they were unwilling to continue to work or frequently they gave out, and it was a puzzle for some time to find out what the trouble was. When the analysis and time-study were put into this department, it was found that part of the trouble was due to the fact that they were not earning so much as workers in adjacent departments, that they were nagged by the foreman, who did not understand how to handle help, and that they were working at a disadvantage in the arrangement of their work places. The first step was to fit up their places so they could work to the best advantage. A time-study then showed that by working according to instructions they could easily do 50 per cent more work. To insure the work being well done, one of the best girls was selected as an inspector and given charge of their work, the foreman having nothing to do with them. A few of the girls were tried on the extra work, working under the constant instruction of the time-study man and being paid an additional amount. All the girls who were physically fitted for this kind of work tried the extra amount, which they did easily. The result of the extra pay, freedom from the nagging of the foreman, and easier working conditions, immediately stopped the difficulty in keeping workers in this department. One or two of these workers, according to the report of the factory nurse, have gained weight since this change was made.

After this policy had been in effect for a while, the constant request of one girl that she be allowed to undertake one-third more work, or double the original amount, was granted with the approval of the factory nurse, who watched her closely. This was a task not set by time-study, but one which the girl herself thought she could undertake. She found, however, that it was too much and gave it up voluntarily, but she is still doing 50 per cent more work than she originally did. She is a girl well fitted for the kind of work and for her a larger task could be given, but tasks are set with the idea of the average worker who is first selected for the particular kind of work.

It must be considered that the effect of task and bonus work

under the proper conditions tends to greater industry, better discipline, a happier disposition and greater interest in work on the part of the workers. Greater regularity, greater accuracy and neatness must and do have an influence on health and character.

Management.—It is probable that the point of view of heads of departments and those responsible for the management becomes quite as much changed as that of the workers. When mistakes are made the responsibility is fixed and the management cannot dodge the fact. A manager also realizes as never before the value that must be placed on analysis. As Mr. Taylor once said: "Thought under scientific management is 75 per cent analysis and 25 per cent common sense."

When a seemingly difficult operation has been analyzed to its last detail, it is not so difficult to reconstruct it on the proper lines. There is, too, an added interest to the management in the feeling that it is working on a plan, the underlying principles of which are already determined, and the details of which are to be developed in accordance with those principles more and more finely as years go by.

Beneath all this there is a good deal of philosophy. It seems to me that this is the best solution of a fair compensation for labor because it puts a premium on the efficiency of both employees and employer, and the success of scientific management depends upon this close co-operation of employer and employee. Along some such line it seems to me will sooner or later be worked out the great problems of labor and capital.

No claim can be laid to this as a panacea for labor troubles, nor a cure for all the mistakes and errors and ills that are contingent on human frailty. There does come a better understanding between management, foremen and workers, and more responsibility is placed on the management than ever before. Without this co-operation, this interlocking of interests, scientific management is but a word.

It is hoped that what has been said may have served to state the question, and to make a little more clear in their true proportions the underlying principles of what we call scientific management.